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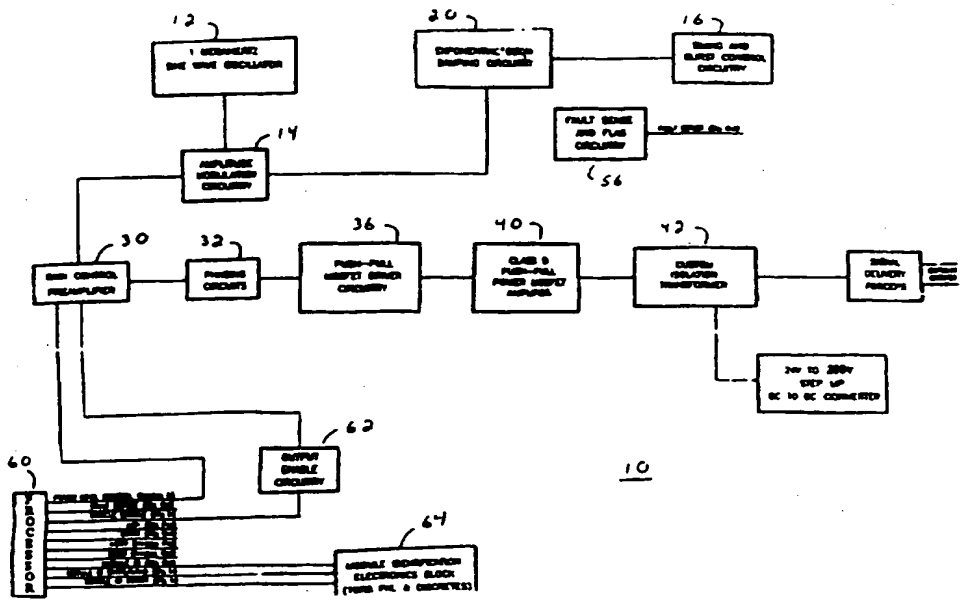
(54) Title: BIPOLAR ELECTROSURGICAL APPARATUS



(57) Abstract

An electrosurgical apparatus comprising a bipolar electrode, and means for generating uniform bursts of high frequency signals (12) having a periodic waveform. The apparatus further c mprises means for impressing substantially identical decaying amplitude envelopes (20) on said uniform bursts, and means (30) for applying said impressed bursts to said electrode. Preferably, the periodic waveform is a sine wave form, and the decaying amplitude envelopes decay at a predetermined rate from a preselected initial amplitude. Also, preferably, each of the bursts of high frequency signals has a given time length, and successive bursts are separated by that same given time length.

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BIPOLAR ELECTROSURGICAL APPARATUS

BACKGROUND OF THE INVENTION

This invention generally relates to bipolar electrosurgical apparatus, and more specifically, to a bipolar cauterizer well suited for use during microsurgery such as micro ophthalmic surgery.

Microsurgical procedures are gaining ever-increasing acceptance in the surgical community for performing precise, minimum invasive surgery for various parts of the body, and one particularly widespread microsurgical application is in the field of ophthalmology. In this application, commonly, a hand piece having a small tool is used either to cut or to mascerate the eye tissue while an irrigation or infusion liquid is brought to the surgery site. The cut or mascerated tissue is carried away from the surgical site by a suction conduit or tube to a collection vessel such as a bag or bottle. A cauterizer may be used to help control bleeding at the surgical site.

Consoles are specifically designed for these ophthalmic procedures. These consoles are used to operate the tools and the suction and infusion lines used in the procedures, and to generate the light that is used to illuminate the surgical site. Typically, these consoles have a modular design and include a multitude of separable or removable modules, with each module being used to operate or to perform a specific task. For example, one module may be employed to operate the hand piece used to cut or mascerate the ey

tissue, another module may be used to infuse and aspirate the surgical site, and a third module may be used to operate the cauterizer.

SUMMARY OF THE INVENTION

An object of this invention is to improve bipolar cauterizers.

Another object of this invention is to apply a damped sinusoidal wave form power signal to a bipolar cauterizer.

These and other objectives are attained with an electrosurgical apparatus comprising a bipolar electrode, and means for generating uniform bursts of high frequency signals having a periodic waveform. The apparatus further comprises means for impressing substantially identical decaying amplitude envelopes on said uniform bursts, and means for applying said impressed bursts to said electrode.

Preferably, the decaying amplitude envelopes decay at a predetermined rate form a preselected initial amplitude. Also, preferably, the periodic waveform is a sine wave form. Each of the bursts of high frequency signals has a given time length, and successive bursts are separated by that same given time length.

Further benefits and advantages of the invention will become apparent form a consideration of the following detailed description given with reference to the accompanying drawings, which specify and show preferred embodiments of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a block diagram illustrating an operating system for a bipolar coagulator.

Figures 2, 3 and 4 illustrate details of the blocks shown in Figure 1.

Figure 5 shows a portion of the output signal generated by an exponential decay circuit of the operating system of Figures 1-4.

Figure 6 shows a portion of a damped sine wave signal generated by the system of Figure 1.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

With reference to Figures 1-4, in system 10, a 1 megahertz sine wave oscillator 12 couples its output to an amplitude modulator circuitry (MC1495C) 14. The oscillator 12 generates a 1 megahertz sine wave of constant amplitude.

A timing control circuit 16, comprised of a timing circuit (LM556N) 20 generates an output pulse every 64 micro-seconds. This output pulse is applied to exponential decay damping circuit 20. In particular, the output pulse from circuit 16 operates a switch (SW201) 22, which discharges capacitor C6 of an RC circuit 24, comprised of capacitor C6 and resistor R6, every 64 microseconds. The RC timing circuit 24 is coupled through (U5A) to pin 4 of amplitude modulation circuit 14 to apply a decaying signal, a portion of which is shown in Figure 5. In the preferred embodiment, this signal has a maximum amplitude at 64

microsecond intervals and decays to zero amplitude in less than 64 microseconds.

The decaying signal modulates the 1 megahertz sine wave signal at amplitude modulation circuitry 14, to generate a damped sine wave signal, as represented in Figure 6. This damped sine wave signal is initiated at a constant periodicity of 64 microseconds and is applied to gain control preamplifier 30, which may be used to adjust the amplitude of the signal. From preamplifier 30, the signal is applied to phasing circuits (U12 and U13) 32, which convert the input signal into a pair of output signals 180° out of phase with one another.

These two output signals are applied to a gain control circuit (AD539) 34, which controls the amplitude of the phase signals. The phase signals are then applied, through push-pull driver circuits 36, to the inputs of class B push-pull power MOSFETs 40. The outputs of the push-pull class B amplifiers are coupled to the primary winding of transformer 42; and the output of the transformer 42 is coupled, via connector 44, to the bipolar electrode forceps, which may be a conventional bipolar coagulator.

Block 46 represents a power supply for transformer 42; and, for example, this power supply may be a 24V to 200V step up DC to DC converter.

The duty cycle of the system 10 is controlled by second timer circuit (LM556) 50. The duty cycle output of this circuit 50 is coupled to one input of gate (U19C) 52, which grounds the power level control input by means of switch (SW201) 54. Preferably, the duty cycle is one second on, one second off--that is,

the power signal is applied to the forceps for one second, with successive applications of the power signal being one second apart.

As represented in Figure 1, various parameters or operating conditions of system 10 may be sensed by appropriate fault detectors 56, which generate one or more signals that may represent those perimeters.

System 10 may be used for a variety of purposes and in a variety of specific application. For example, system 10 may be used during ophthalmic surgery to cauterize the surgical site. Even more specifically, system 10 is very well suited for use in a modular console that includes a multitude of other modules for operating other instruments or for preforming other tasks related to ophthalmic surgery. For example, system 10 may be used in the console disclosed in co-filed PCT application no. _____ for which priority is based on U.S. s/n 08/330,926 (Attorney docket PD-4395), the disclosure of which is herein incorporated by reference.

In such an application system 10 or the console includes processor 60. The console processor, generally, may be used to control the overall operation of the console and to act as a communications interface between the console and the operator. Also, commands to activate or enable power system 10 may be generated by the console processor and transmitted to system 10 via enable circuit 62. Data transmitted in or by system 10 may be transmitted to the console processor to keep that processor, and the console operator, informed of that data.

In Figure 1, block 64, represents an electronics module identification block, which is provided with an electronically readable serial number, identifying the power system.

While it is apparent that the invention herein disclosed is well calculated to fulfill the objects previously stated, it will be appreciated that numerous modifications and embodiments may be devised by those skilled in the art, and it is intended that the appended claims cover all such modifications and embodiments as fall within the true spirit and scope of the present invention.

CLAIMS

1. Electrosurgical apparatus comprising:

a bipolar electrode;

means for generating uniform bursts of a high frequency signal having a periodic waveform;

means for impressing substantially identical decaying amplitude envelopes on said uniform bursts; and

means for applying said impressed bursts to said electrode.

2. Apparatus according to Claim 1, wherein each of said envelopes has a predetermined rate of decay from a preselected initial amplitude.

3. Apparatus according to Claim 2, wherein said predetermined rate of decay is an exponential rate of decay.

4. Apparatus according to Claim 1, wherein said periodic waveform is a sine wave form.

5. Apparatus according to Claim 1, wherein said periodic waveform has a frequency of approximately one megahertz.

6. Apparatus according to Claim 1, wherein the generating means separates adjacent bursts.

7. Apparatus according to Claim 1, wherein:

each of said bursts has a length equal to a given period of time; and

successive bursts are separated by said given period of time.

8. Apparatus according to Claim 7, wherein said given period of time is approximately one second.

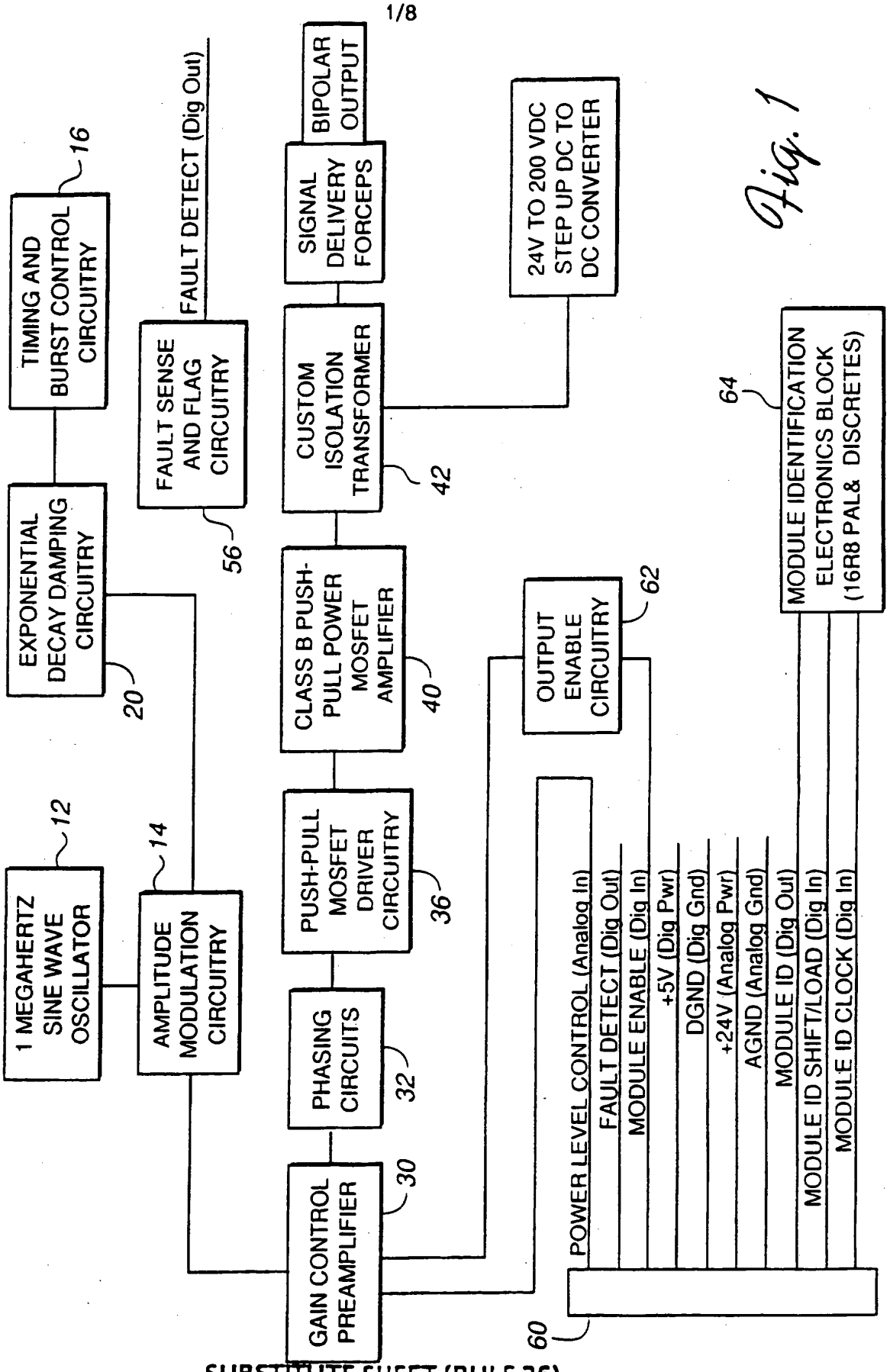

1 MEGAHERTZ SINE WAVE OSCILLATOR
12
AMPLITUDE MODULATION CIRCUITRY
14
EXPONENTIAL DECAY DAMPING CIRCUITRY
20
TIMING AND BURST CONTROL CIRCUITRY
16
FAULT SENSE AND FLAG CIRCUITRY
56
FAULT DETECT (Dig Out)
PHASING CIRCUITS
32
PUSH-PULL MOSFET DRIVER CIRCUITRY
36
CLASS B PUSH-PULL POWER MOSFET AMPLIFIER
40
CUSTOM ISOLATION TRANSFORMER
42
SIGNAL DELIVERY FORCEPS
BIPOLAR OUTPUT
24V TO 200 VDC STEP UP DC TO DC CONVERTER
GAIN CONTROL PREAMPLIFIER
30
OUTPUT ENABLE CIRCUITRY
62
MODULE IDENTIFICATION ELECTRONICS BLOCK (16R8 PAL& DISCRETES)
64
POWER LEVEL CONTROL (Analog In)
FAULT DETECT (Dig Out)
MODULE ENABLE (Dig In)
+5V (Dig Pwr)
DGND (Dig Gnd)
+24V (Analog Pwr)
AGND (Analog Gnd)
MODULE ID (Dig Out)
MODULE ID SHIFT/LOAD (Dig In)
MODULE ID CLOCK (Dig In)
60

Fig. 1

Fig. 2

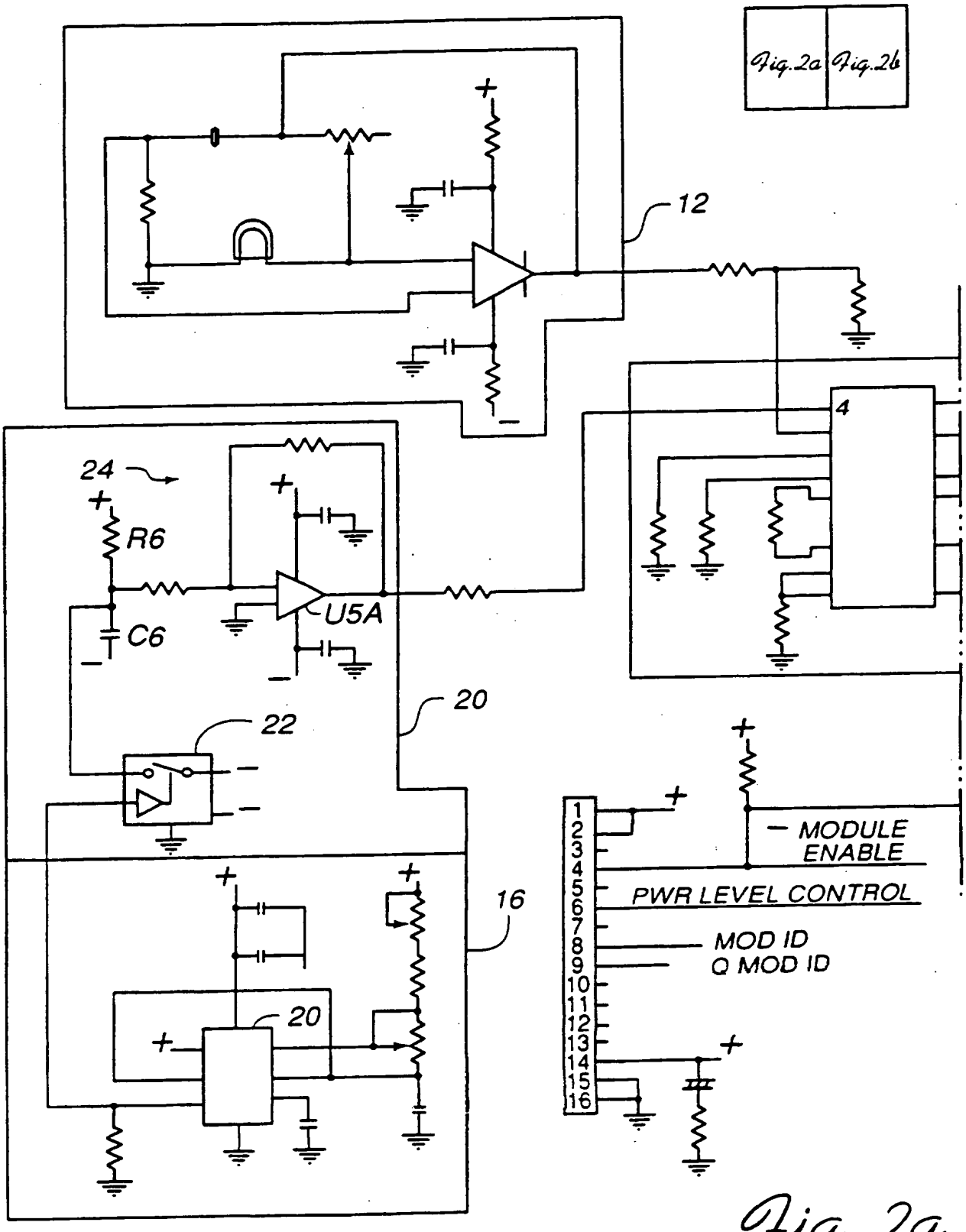


Fig.2a
Fig.2b
12
4
24
R6
C6
U5A
20
22
16
20
MODULE ENABLE
PWR LEVEL CONTROL
MOD ID
Q MOD ID
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16

Fig. 2a

Fig. 2b

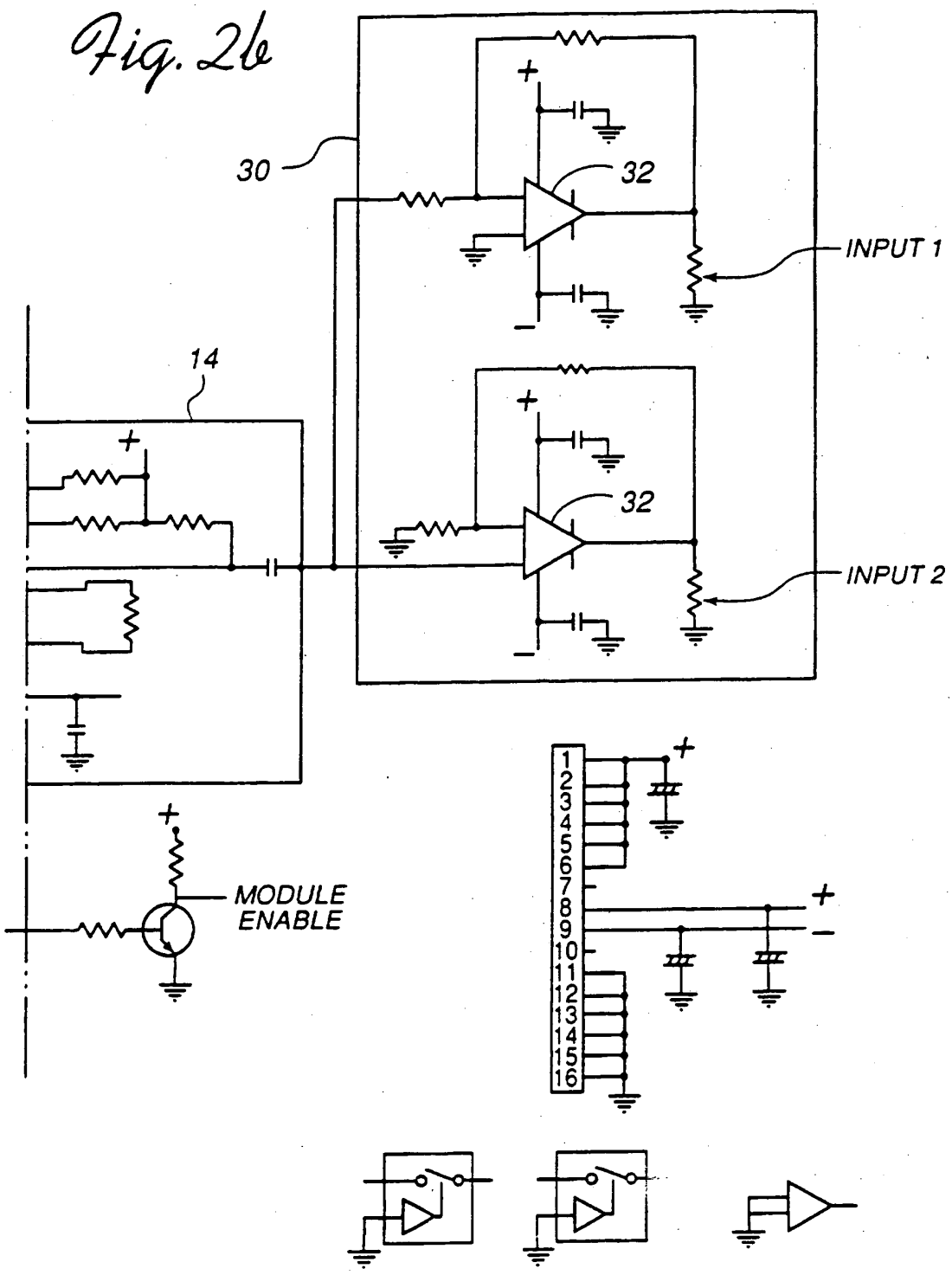

30
32
INPUT 1
14
32
INPUT 2
MODULE
ENABLE
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16

Fig. 3

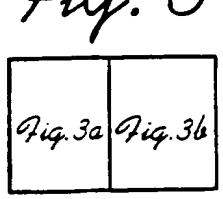


Fig. 3a
Fig. 3b

Fig. 3a

32
VCA GAIN
INPUT 1
INPUT 2
+
−
30
40
PUSH DRV
PULL DRV
42
44

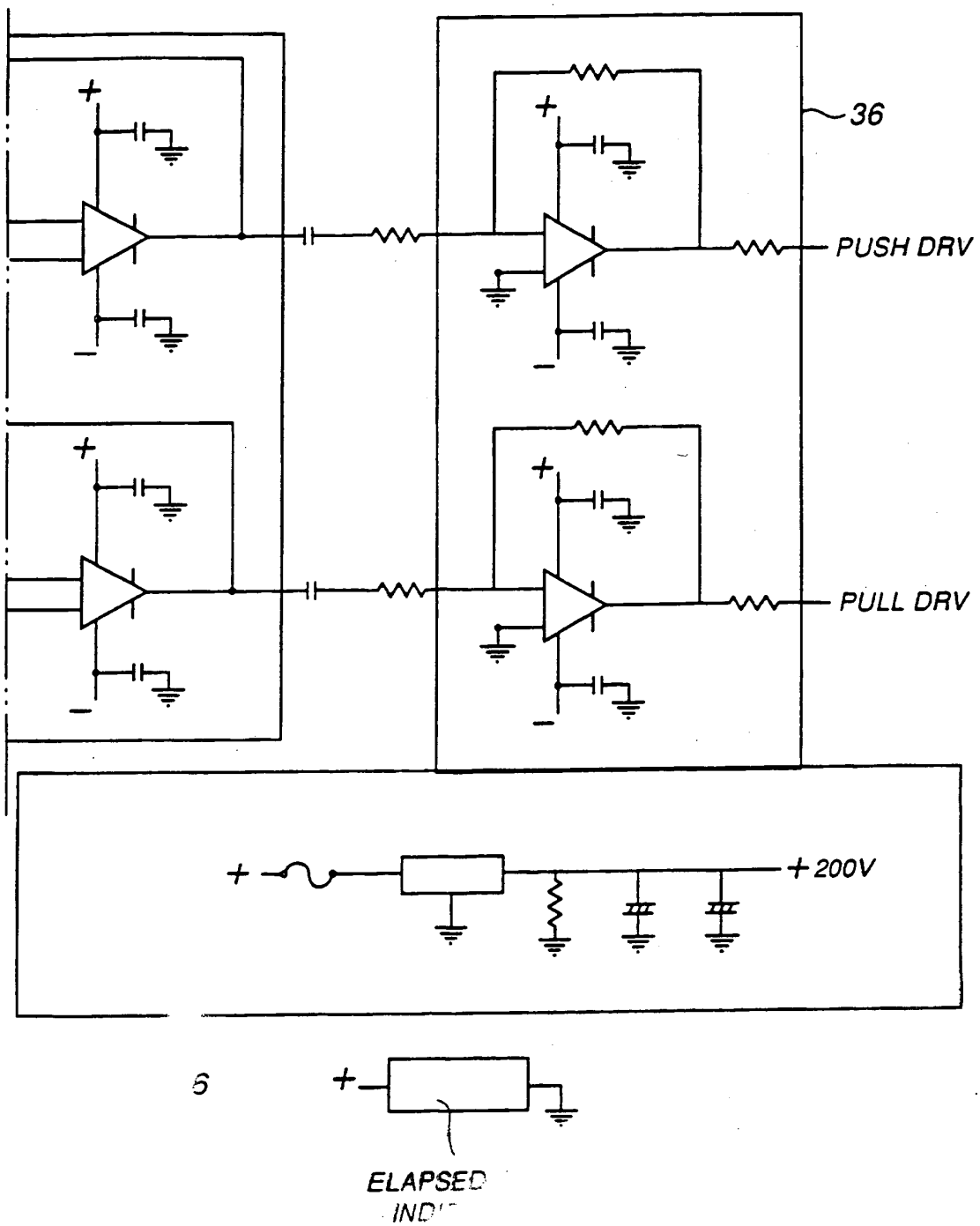


Fig. 3b

Fig. 4

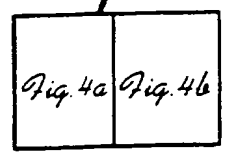
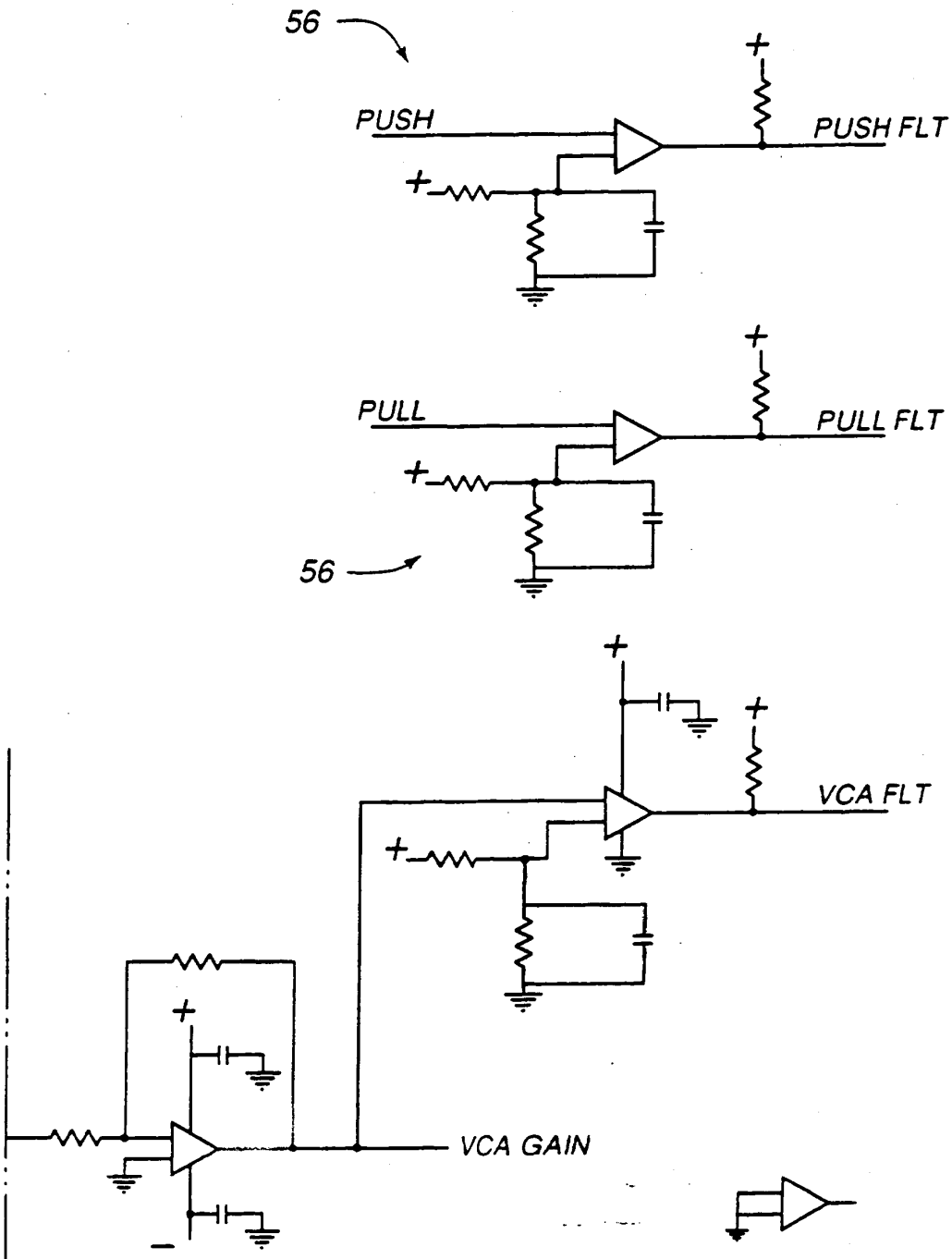


Fig. 4a
Fig. 4b

Fig. 4a

64
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
Q MOD ID
MODULE ENABLE
MOD ID
— MODULE ENABLE
50
52
54

Fig. 4b



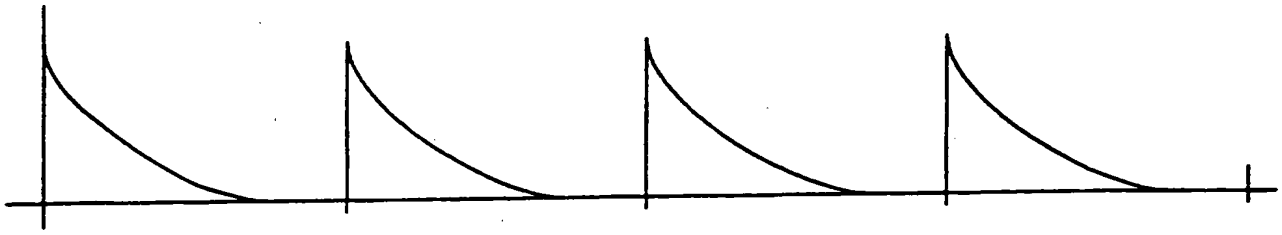


Fig. 5

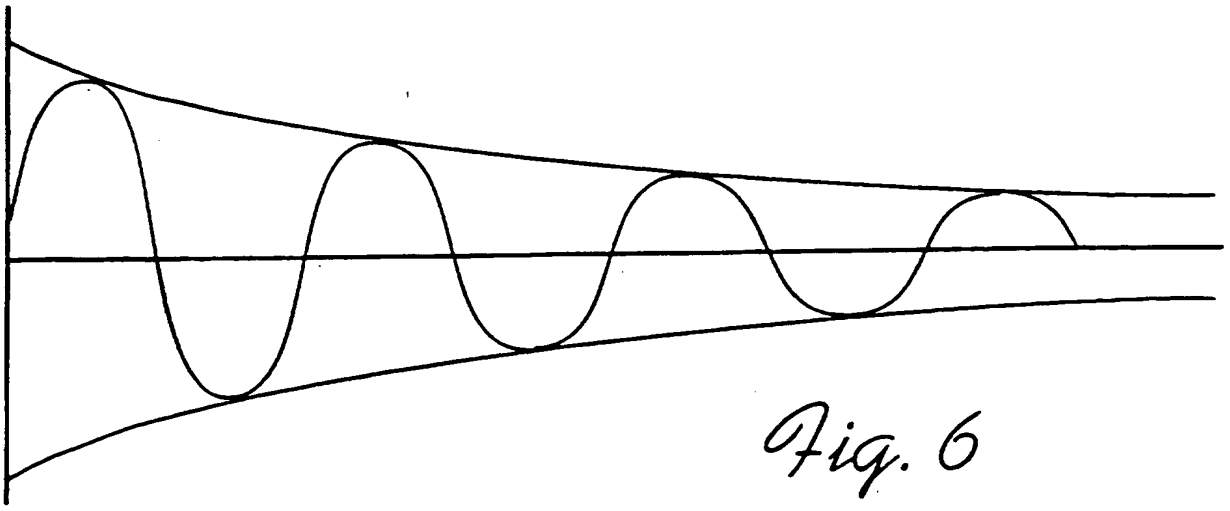


Fig. 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US95/13858

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :A61B 17/39
US CL :606/34
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 606/32-34, 37-42

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US, A, 5,318,563 (MALIS ET AL.) 07 June 1994, see whole document.	1-8 --- 1-8
A	US, A, 3,923,063 (ANDREWS ET AL/) 02 December 1975, see whole document.	1-8
A	US, A, 5,167,660 (ALTENDORF) 01 December 1992, see whole document.	1-8

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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